FORESTRY

FOREST RESOURCE DEVELOPMENT AGREEMENT

Canada

BC

FRDA Report 096

Developing Herbicide Efficacy Tables for the Southern Interior

by
C.F. Thompson

B.C. Ministry of Forests
Nelson Forest Region
518 Lake Street
Nelson, B.C.
V1L 4C6

October 1989

ISSN 0835 0752

ECONOMIC & REGIONAL DEVELOPMENT AGREEMENT

Canada

BC

90-04750/

Funding for this publication was provided by the Canada-British Columbia Forest Resource Development Agreement - a five year (1985-90) $300 million program cost-shared equally by the federal and provincial governments.

Canadian Cataloguing in Publication Data

Thompson, Christopher F., 1943 –
Developing herbicide efficacy tables for the southern interior

(FRDA report, ISSN 0835-0752 ; 096)

Issued under Canada-BC Forest Resource Development Agreement.
Co-published by B.C. Ministry of Forests.
"Canada/BC Economic & Regional Development Agreement."
Includes bibliographical references.
ISBN 0-7726-1030-4

1. Herbicides - British Columbia. 2. Conifers - Weed control - British Columbia. 3. Nelson Forest Region (B.C.) I. Canada. Forestry Canada. II. British Columbia. Ministry of Forests. III. Canada-British Columbia Forest Resource Development Agreement. IV. Canada/BC Economic & Regional Development Agreement. V. Title. VI. Series.

SB950.3.C3T56 1989 634.9'6954 C89-092260-8

© 1989 Government of Canada,
Province of British Columbia

This is a joint publication of Forestry Canada and the British Columbia Ministry of Forests.

Produced and distributed by the Ministry of Forests, Research Branch.

For additional copies and/or further information about the Canada-British Columbia Forest Resource Development Agreement, contact:

Forestry Canada
Pacific Forestry Centre
506 West Burnside Road
Victoria, B.C. V8Z 1M5
(604) 388-0600

or

B.C. Ministry of Forests
Research Branch
31 Bastion Square
Victoria, B.C. V8W 3E7
(604) 387-6719

TABLE OF CONTENTS

INTRODUCTION 1

OBJECTIVES 1

METHOD 1

Treatment Assessment 1

RESULTS 2

Herbicide Efficacy 2
Crop Tree Tolerance 2

DISCUSSION 3

Herbicide Efficacy 3
Crop Tree Tolerance 5

CONCLUSIONS 5

REFERENCES 6

APPENDICES

1 Summary of operational applications for this project 7

2 Herbicide efficacy assessed after one growing season using the ECW 100 point scale 8

3 Average herbicide efficacy in the Nelson Forest Region, based on this and other studies 9

FIGURES

1 Efficacy of glyphosate after one growing season 3

2 Efficacy of hexazinone after one growing season 4

INTRODUCTION

Species-treatment efficacy tables for forest-use herbicides are available in the U.S. (Gratkowski 1975; Newton and Knight 1981, Conard and Emmingham 1984a, 1984b; Boyd *et al.*), but there are two impediments to their immediate application within the Nelson Forest Region. First, species of concern in the region (e.g., *Rhododendron albiflorum*) are not included in the tables. Second, we had reservations about applying the tables in this region, whose ecological environments differ from those in the U.S. Similar, locally developed tables do not exist for the Nelson Forest Region.

In the absence of comprehensive controlled herbicide rate and timing trials, this project was established to examine the utility of operational herbicide applications as a starting point for creating efficacy tables for the region.

OBJECTIVES

This study had two primary objectives:

1. to assess the impact of herbicide treatment on target vegetation species in available operational applications; and
2. to use these assessments to construct a first approximation table of chemical treatments versus target species showing treatment efficacy.

METHOD

Candidate areas were located from operational records and given priority for assessment on the basis of treatment and target species. The purpose of ranking was to ensure that all species-treatment combinations available were sampled and that the more frequent species-treatment combinations were sampled most often.

Fourteen treated blocks were selected. They were stratified ecologically, topographically, and according to application rate or method, yielding 27 strata. Within each stratum, 20 plots were located systematically on a randomly originating grid designed to sample the whole stratum.

Up to four species were selected for assessment, because they were named as target species on the pesticide permit, were of sufficient frequency that they should have been named as target species, or were deemed significant for other reasons (e.g., wildlife browse).

In each plot, the individuals selected for assessment were those closest to the plot centre. If no individuals of the selected target species were within a radius of 4 m from the plot centre, that species was considered to be absent from the plot.

Certain treated areas were quite small. In those, the 4-m radius was reduced if necessary, and a certain amount of overlapping was permitted, provided the same individual was not assessed twice.

Treatment Assessment

Wherever possible, woody species were assessed. It was felt that with herbaceous species there would be too much uncertainty about their dimensions and vigour before treatment to permit a reliable assessment of treatment effect. Reliably identifying their presence before treatment was also doubtful. The lignified remains of woody species acted as proof of their dimensions and vigour before treatment. In

retrospect, we were probably overconservative about the reliability of assessing treatment impact on herbaceous species. Certain "semi-lignified" species such as fireweed or bracken could likely have been included in the survey with the use of stem density assessment. A methodology for this has not been explored.

It was planned that each selected individual was to be assessed on the ECW 100-point scale (Expert Committee on Weeds 1983).[1] The intent was to compare the selected treated individual with the general character of individuals of the same species in an adjacent untreated portion. In practice, the assessment consisted of comparing the current appearance of the selected individual with what the lignified remains from last year suggested it should have been, had no chemical treatment been carried out. In most cases this worked well. Each individual was assessed on a 10-point scale (0, 10, 20,... etc.). After averaging, the assessment became a 100-point scale. As used here, an assessment of 100 indicates apparent mortality of the aerial portions of the plant.

RESULTS

Data collected are summarized in Appendices 1 and 2.

Herbicide Efficacy

Roundup® (glyphosate) was the most frequently used chemical (Appendix 2). Rates ranged from 1.4 kg ai/ha (4 L/ha) in one project to 2.7 kg ai/ha (8 L/ha) in another. This latter rate is higher than the current label recommendations of 2.1 kg ai/ha for site preparation. Of the 21 glyphosate strata sampled in the project, 6 were at 5 L/ha and 13 were at about 6 L/ha (2-2.136 kg ai/ha).

Other herbicides used were Velpar-L® (hexazinone), which was used in one small unreplicated trial of four application rates on the same date, and 2,4-D (ester) and Asulox F® (asulam), each used in one operation.

The species of significance varied considerably between areas. Further complicating the comparison of efficacy between treatment rates and areas was the large variation of effect between samples. For certain species-treatment combinations, the coefficient of variation for percent efficacy was as high as 1.27.

No analysis was attempted other than the simple summaries presented here. It was felt that the variability of the individual survey results plus the relatively small number of samples would hinder productive analysis of the various other factors involved.

Crop Tree Tolerance

An attempt was made to assess conifer tolerance, using individuals encountered in each plot. Although the majority of the glyphosate treatments were applied after active conifer growth ceased, damage believed attributable to the herbicide was noted in all strata but not on all species encountered in each stratum.[2] The nature of the damage varied from operation to operation and from species to species. No consistent trends were detected.

Too few operations using other chemicals prohibited any generalizations being made about conifer tolerance to those chemicals.

---

1 This is a linear scale used for visual damage assessment, with 0 indicating no control and 100 indicating death of the weed.

2 At rates greater than 5 L/ha, crop damage would be expected at virtually any timing (R.J. Whitehead, Forestry Canada, pers. comm.)

DISCUSSION

Herbicide Efficacy

The only projects for which conclusions can be made with confidence are those that were treated with glyphosate at 5 L/ha and 6 L/ha. These are the only levels that have a measure of "replication."

Despite the variability between projects, there was a reasonable amount of consistency between the average efficacies for the two levels. Thus, for the four species (*Alnus viridis*, *Rubus idaeus*, *Rubus parviflorus*, and *Vaccinium membranaceum*) only *A. viridis* (alder) appeared to have reacted more to the heavier dosage (Figure 1).

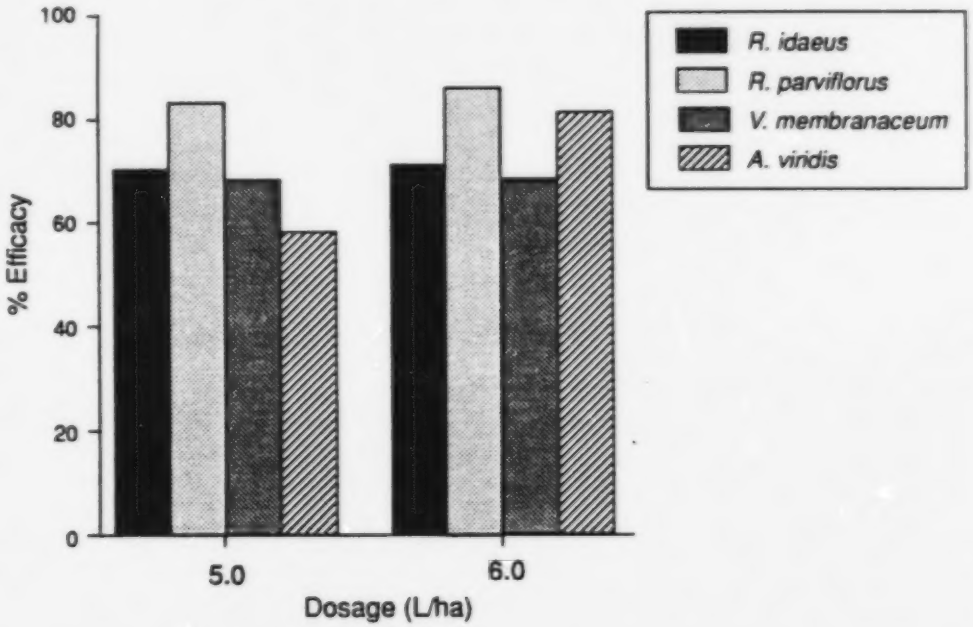

FIGURE 1. Efficacy of glyphosate after one growing season.

The four applications of hexazinone, in an unreplicated trial installed by Kootenay Lake District and Dupont Ltd. in 1984, showed a positive correlation of efficacy to dosage (Figure 2). As well, *V. membranaceum* (black huckleberry) appeared to be more resistant to damage by hexazinone than the other species assessed. It also appeared to be more resistant to glyphosate (Figure 1).

The response of *R. idaeus* (red raspberry) to glyphosate was intermediate between that of *R. parviflorus* (thimbleberry) and *V. membranaceum*. It did, however, have another notable response.

Often *R. idaeus* closest to the plot centre was ignored because there was no evidence of the plant at that spot at the time of the spray. Instead, another individual plant was selected that had adjacent woody remains to confirm its presence during the spray. Usually the selected individual showed a relatively high injury level, whereas the ignored individual was growing vigorously with no evident herbicide effect. The healthy individual was also usually growing in a patch of heavily affected fireweed or bracken. What appeared to be happening was that one species (most frequently raspberry) was rapidly exploiting an ecological void that had been created by the apparent elimination of fireweed or bracken. Whether the fireweed or bracken had been eliminated is unknown. At the time of the survey there was little evidence of their presence, but no statements can be made about their future presence on the site.

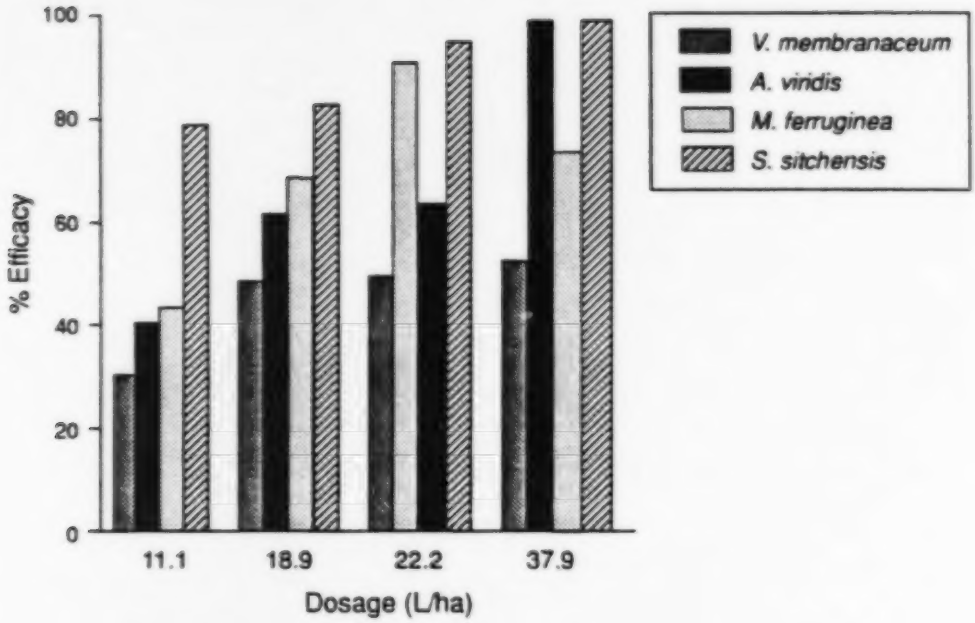

FIGURE 2. Efficacy of hexazinone after one growing season.

Rubus idaeus canes are dominantly biennial. What we were seeing, and ignoring, were primocanes, originating from a point where no individuals were apparently present before treatment. The individuals selected for assessment were usually floricanes–in most cases demonstrating herbicide effects–or primocanes that originated within about 10 cm of dead canes. The proximity of the dead canes was taken as an indication of the presence of raspberry on that spot before treatment. This may or may not have been a correct assumption. However, it is felt that the data collected are a realistic reflection of the relative aerial presence of that species 1 year after herbicide treatment.

The only way to generate more reliable information would be through both pre- and post-treatment assessments of the relative abundance and competitive importance of raspberry.

The origin of the opportunistic raspberry was not examined. In most cases the vigour of the invasion suggested origin from the roots, although origin from seed cannot be discounted. Discussions with others suggest that the roots of this species (and others) are rarely completely killed, presumably because of incomplete chemical translocation. The surviving roots thus provide a well-distributed source for reinvasion.

Much of what has been said above about raspberry can also be said about thimbleberry,[3] except that in this survey we found few examples of apparently new shoots of thimbleberry in locations that had no evidence of it being there before treatment. This may indicate greater treatment impact (as reflected by a greater apparent reduction of its aerial components), or it may reflect a slightly lower level of opportunism.

The intended effect of all herbicide treatments is to shift the species composition and structure to a complex dominated by crop species, or at least to a complex where crop species have a competitive edge. As the data show, the short-term effectiveness on different species differs by species and, in a few species, by application rate (over the range of rates examined). It also varies with the timing of

3 J.C. Pollack, B.C. Min. For. pers. comm.

application, although this factor could not be examined because of the limited range of treatment dates available in this survey. The recovery rate of each species also differs, with the result that a shift in the species composition occurs following herbicide treatment to a site. The opportunism of red raspberry is possibly one symptom of that shift.

This project does not demonstrate the direction of that shift, or whether the shift will be favourable to conifer establishment and growth. The reduction in the overall vegetation levels may be brief, and the resultant complex may provide an even less favourable environment to tree growth, with the only benefit to tree performance coming from the short void between the reduction of the first complex and the dominance of the second. Data to quantify the speed and pattern of the redeveloping complex cannot be produced by a single assessment procedure described here. What is required is the establishment of permanent pre- and post-treatment plots.

Crop Tree Tolerance

No observations on crop tolerance are presented.

The majority of operations surveyed for this project were herbicide applications in late August or early September, which is the time currently viewed as appropriate for brushing operations. In spite of this, most of the application rates selected were rates usually prescribed for site preparation. Furthermore, no information was available on the phenological state of the vegetation at the time of application, or of the conifer species. It therefore proved very difficult to draw any conclusions on crop tree tolerance, a concept that depends highly on the interaction of rate, timing, and phenology. In addition, the survey procedure did not document conifer height relative to adjacent non-conifer vegetation height. Overtopping vegetation could have protected smaller conifers from the herbicide spray.

CONCLUSIONS

Several conclusions were reached:

- The method used was relatively effective in quantifying the above-ground impact of herbicide application on woody species present at the time of treatment. However, because the assessment was of the above-ground portion of the vegetation, the survey may overestimate the impact for some species when compared with assessments that use 100% to indicate mortality. The method was not effective in quantifying impact on herbaceous species, but possibly could be with a modified technique and careful species selection.
- The method used cannot be expected to account for the change in species composition due to herbicide treatment. For these data to be acquired, permanent pre- and post-treatment plots and untreated controls are needed to separate successional change from treatment-induced change.
- Species of concern that are unique to this region were poorly represented in the areas sampled, and thus little was learned about the potential for their control using herbicides.
- Controlled herbicide trials including no-treatment controls assessed over an extended period are the only effective method of generating reliable information on herbaceous species and on the species shifts that occur as a result of herbicide treatments.

A skeleton species-treatment table containing results from this project and from other sources in the Nelson Region is presented in Appendix 3. This table is presented for comment and is offered as a basis for further testing certain species-treatment combinations. The ratings in the table are largely subjective on the part of the author. Comparison with published tables from elsewhere is invited.

REFERENCES

Boyd, R.J., D.L. Miller, F.A. Kidd, and C.P. Ritter. 1985. Herbicides for forest weed control in the Inland Northwest. A summary of effects on weeds and conifers. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. INT-195.

Conard, S.G. and W.H. Emmingham. 1984a. Herbicides for shrub control on forest sites in northeastern Oregon and northern Idaho. Oreg. State Univ., For. Res. Lab., Special Publ. 5.

_____. 1984b. Herbicides for grass and herbaceous weed control in Oregon and Washington. Oreg. State Univ., Res. Lab., Special Publ. 7.

Expert Committee on Weeds. 1983. Instructions for the preparation of Research Abstracts. Misc. Mimeo.

Gratkowski, H. 1975. Silvicultural use of herbicides in Pacific Northwest forests. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. PNW-37.

Newton, M. and F.B. Knight. 1981. Handbook of weed and insect control chemicals for forest resource managers. Timber Press, Beaverton, Oreg.

APPENDIX 1. Summary of operational applications for this project

Location	Permit	Chemical	Rate (kg ai/ha)	Applied (at L/ha)	Method	Purpose	Date applied	BGCZ[a]	EA[b]
Kitchener Creek	106-641 84/86	2,4-D ester	1.1	45.5	Ground	Site prep	84/06/06	ICHa2	1
Crawford Creek	104-583 84/86	asulam	1.1	45	Ground	Conifer rel.	84/08/21	ICHa1	1
Potlatch Cr. A	104-028 85/87	glyphosate	1.424	96	Aerial		85/08/30	ICHb	1
Tangier River B	104-024 85/87	glyphosate	1.780		Aerial		85/09/06	ICHb	1
Westside E	104-025 85/87	glyphosate	1.780	95	Aerial		85/08/28	ICHb	1
Horne Creek	211-003 84/86	glyphosate	1.780	45	Aerial	Brush	85/08/22	ICHb	3
Tangier River C	104-024 85/87	glyphosate	1.780	95	Aerial		85/09/06	ICHb	4
Westside D	104-025 85/87	glyphosate	1.780	95	Aerial		85/08/28	ICHb	4
Script Creek	211-005 85/87	glyphosate	1.780	45	Aerial	Brush	85/08/22	ICHb	4
Kamma Creek	261-001 84/86	glyphosate	2.0	45	Ground	Site prep	84/08/29	ICHa2	4
Smith Creek A	277-001 85/87	glyphosate	2.136	60	Aerial	Site prep	85/08/28	ESSFb	1
Smith Creek B	277-001 85/87	glyphosate	2.136	90	Aerial	Site prep	85/08/28	ESSFb	4
Smith Creek D	277-001 85/87	glyphosate	2.136	60	Aerial	Site prep	85/08/28	ICHb	1
Smith Creek E	277-001 85/87	glyphosate	2.136	90	Aerial	Site prep	85/08/28	ICHb	1
Smith Creek C	277-001 85/87	glyphosate	2.136	90	Aerial	Site prep	85/08/28	ICHb	4
Maryland Cr. A	104-762 84/86	glyphosate	2.133		Ground	Demo	84/07/06	ICHa2	4
Echo Lake C	104-025 85/87	glyphosate	2.136	94	Aerial		85/08/26	ESSFb	1
Tangier River A	104-024 85/87	glyphosate	2.136		Ground		85/09/06	ICHb	1
Yellow Creek B	104-028 85/87	glyphosate	2.136	94	Ground		85/08/29	ICHb	1
Yellow Creek C	104-028 85/87	glyphosate	2.136	94	Aerial	Site prep	85/08/29	ICHb	1
Echo Lake A	104-025 85/87	glyphosate	2.136	94	Aerial		85/08/26	ICHb	4
Echo Lake B	104-025 85/87	glyphosate	2.136	94	Ground		85/08/26	ICHb	4
Meadow Creek	104-577 84/86	glyphosate	2.7		Ground	Conifer rel.	84/08/14	ICHa2	1
Maryland Cr. B	104-762 84/86	hexazinone	2.66	11.1	Spot	Demo	84/07/06	ICHa2	4
Maryland Cr. C	104-762 84/86	hexazinone	4.5	18.9	Spot	Demo	84/07/06	ICHa2	4
Maryland Cr. D	104-762 84/86	hexazinone	5.32	22.2	Spot	Demo	84/07/06	ICHa2	4
Maryland Cr. E	104-762 84/86	hexazinone	9.1	37.9	Spot	Demo	84/07/06	ICHa2	4

a BGCZ = Biogeoclimatic Zone.
b EA = Ecosystem Association.

APPENDIX 2. Herbicide efficacy assessed after one growing season using the ECW 100 point scale

Chemical	Rate (L/ha)	Rate (kg ai/ha)	BGCZ[a]	EA[b]	RUPA[c]	RUID	VAME	ALVI	OPHO	MEFE	SALIX	SOSI	SARA	ACGL	RHAL
Glyphosate	4.0	1.42	ICHb	1	36	22			41				47*		
Glyphosate	5.0	1.78	ICHb	1	77	58	54	30*							
Glyphosate	5.0	1.78	ICHb	1	91	77	76	65							
Glyphosate	5.0	1.78	ICHb	3	87	89			96*		79				
Glyphosate	5.0	1.78	ICHb	4		80	76	82						70*	
Glyphosate	5.0	1.78	ICHb	4	70*	49	58								
Glyphosate	5.0	1.78	ICHb	4	92	73	72*							86	
Glyphosate	6.0	2.00	ICHa2	4	85		79	95		99					
Glyphosate	6.0	2.10	ESSFb	1			78*	77					99*		77*
Glyphosate	6.0	2.10	ESSFb	4	99	89		88	91						
Glyphosate	6.0	2.10	ICHb	1		64		67	93					91*	
Glyphosate	6.0	2.10	ICHb	1	94				85*	83*			44*		
Glyphosate	6.0	2.10	ICHb	4		62	59*	82*	77						
Glyphosate	6.0	2.13	ICHa2	4			47			83		81*			
Glyphosate	6.0	2.14	ESSFb	1	99	93	76*								95*
Glyphosate	6.0	2.14	ICHb	1	80*	59	65	82							
Glyphosate	6.0	2.14	ICHb	1	89	89			96*		79				
Glyphosate	6.0	2.14	ICHb	1	57	45			75				95*		
Glyphosate	6.0	2.14	ICHb	4	87	80		79			80*				
Glyphosate	6.0	2.14	ICHb	4	75	71		59			46*				
Glyphosate	7.6	2.70	ICHa2	1	73	58	87*								
Asulam		1.10	ICHa1	1	70	57									
2,4-D		1.10	ICHa2	1	55		23	73			53				
Hexazinone	11.1	2.66	ICHa2	4			31	40		44		77			
Hexazinone	18.9	4.50	ICHa2	4			48	62		69		83			
Hexazinone	22.2	5.32	ICHa2	4			49	91		65		94			
Hexazinone	37.9	9.10	ICHa2	4			55	99		75		99			

a BGCZ = Biogeoclimatic Zone.
b EA = Ecosystem Association.
c Species names and abbreviations: ACGL = *Acer glabrum* (Douglas maple); ALVI = *Alnus viridis* ssp. *sinuata* (Sitka alder); MEFE = *Menziesia ferruginea* (false azalea); OPHO = *Oplopanax horridus* (devil's club); RHAL = *Rhododendron albiflorum* (white-flowered rhododendron); RUID = *Rubus idaeus* (red raspberry); RUPA = *Rubus parviflorus* (thimbleberry); SALIX = *Salix* sp. (willows); SARA = *Sambucus racemosa* (red elderberry); SOSI = *Sorbus sitchensis* (Sitka mountain ash); VAME = *Vaccinium membranaceum* (black huckleberry).
* Indicates values based on less than 10 samples.

APPENDIX 3. Average herbicide efficacy in the Nelson Forest Region, based on this and other studies

Species	Glyphosate (L/ha)[a]				Hexazinone (L/ha)[b]				
	3	4	5	6	11	12	15	19	22
Acer glabrum			S	S					
Alnus viridis sinuata			M	G				S	S
Amelanchier alnifolia	G	G							
Menziesia ferruginea				S				S	S
Oplopanax horridus				G					
Physocarpus malvaceus	G	G							
Populus balsamifera						S	S		
Rubus idaeus			G	G					
Rubus parviflorus			G	G					
Salix spp.			S	S					
Sorbus sitchensis					S			S	S
Symphoricarpos albus	G	G							
Vaccinium membranaceum			S	M				S	S

[a] Method = foliar, Season = Fall
[b] Method = spot, Season = Spring

Effect: G = good effect
M = moderate effect
P = poor effect
S = shows promise